

Electrocardiogram Experiment

using latin square design

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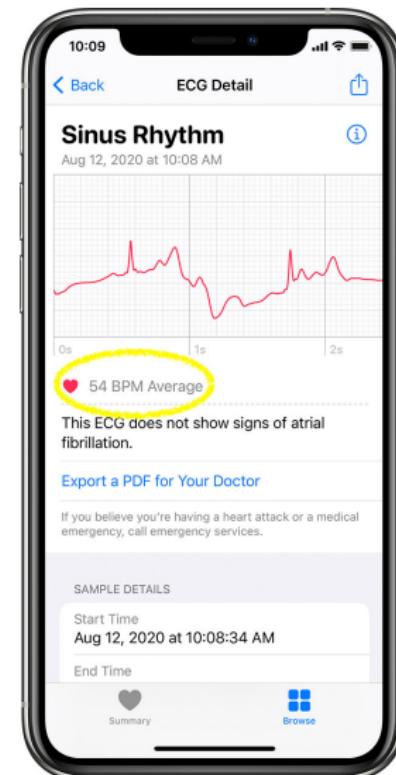
Section 1

Introduction

Electrocardiogram Experiment

Goal

- Does caffeine affect ECG or *heart rate*?
- Caffeine: *coffee*
- Output: Average heart rate (BPM)



Latin Square Design

Table 1: Reduced Latin Square

Row	Column			
	1	2	3	4
1	A	B	C	D
2	B	C	D	A
3	C	D	A	B
4	D	A	B	A

- Each treatment once in each row and column
- We allocate 4 treatment levels randomly

Section 2

Design and the Data

Blocking Factors

Caffeine intake depends on the following two factors (한동하, 2018).

Row: Coffee-to-water ratio

- ① 1:0 (Espresso, 40 ml)
- ② 1:2.5 (Water 100 ml)
- ③ 1:5 (Water 200 ml)
- ④ 1:7.5 (Water 300 ml)

Column: Drinking speed

- ① ≤ 5 sec
- ② 5-15 sec
- ③ 15-30 sec
- ④ $30 <$ sec



Factor

Intake of caffeine (himynameisabcde, 2020) from Starbucks by Nespresso

- ① House blend: 74.5 mg
- ② Sumatra: 54.5 mg
- ③ Decaf espresso roast: 3 mg
- ④ Just water: 0 mg

Output

Value: Average heart rate

- in BPM
- Notations from the course (Lee, 2021)
- Since there exists variation, we consider difference of BPM after and before:

$$y_{rc}^{post} - y_{rc}^{pre}$$

Measure

- Apple Watch Series 4
- ECG app
- Algorithm version: 1



Randomized Assignment

- ① Randomly allocate (1, 2, 3, 4) to previous (A, B, C, D)
- ② Assign to above Table 1

```
set.seed(1)
sample(LETTERS[1:4])
#> [1] "A" "C" "D" "B"
```

- Ⓐ House blend (74.5 mg)
- Ⓑ Water (0 mg)
- Ⓒ Sumatra (54.5 mg)
- Ⓓ Decaf espresso roast (3 mg)

Latin Square

Table 2: Design of the Experiment

Water	Drinking Speed			
	<=5	5-15	15-30	30<
0 ml	H(74.5)	W(0)	S(54.5)	D(3)
100 ml	W(0)	S(54.5)	D(3)	H(74.5)
200 ml	S(54.5)	D(3)	H(74.5)	W(0)
300 ml	D(3)	H(74.5)	W(0)	H(74.5)

¹ 'Water' is the coffee-to-water ratio (divide with 40 ml)

² Numbers in the brackets indicate caffeine (in mg)

- Use *reduced latin square*
- Randomization test afterward

Controlling the Other Variables

Coffee

- Drink coffee every morning (between 8:30 a.m. and 9:00 a.m.)
- after eating a piece of bread
- Nespresso machine: Pixie C61 in my home

Measure

- Sitting at the table
- Rest my arms on the table
- Use the same strip
 - Nike sport band
 - of same fit (8-th)
- and other instructions in
<https://support.apple.com/en-us/HT208955>

Section 3

Analysis

Dataset

```
(ecg <- read_csv("../data/raw/ecg.csv"))
#> # A tibble: 16 x 7
#>   id     date      water speed coffee  pre  post
#>   <dbl> <date>    <dbl> <dbl>  <dbl> <dbl> <dbl>
#> 1 1 2021-04-22     1     1     1    80    89
#> 2 2 2021-04-23     1     2     4    77    78
#> 3 3 2021-04-24     1     3     2    76    83
#> 4 4 2021-04-25     1     4     3    76    79
#> 5 5 2021-04-26     2     1     4    75    77
#> 6 6 2021-04-27     2     2     2    77    83
#> 7 7 2021-04-28     2     3     3    90    93
#> 8 8 2021-04-29     2     4     1    NA    NA
#> 9 9 2021-04-30     3     1     2    NA    NA
#> 10 10 2021-05-01   3     2     3    NA    NA
#> 11 11 2021-05-02   3     3     1    NA    NA
#> 12 12 2021-05-03   3     4     4    NA    NA
#> 13 13 2021-05-04   4     1     3    NA    NA
#> 14 14 2021-05-05   4     2     1    NA    NA
#> 15 15 2021-05-06   4     3     4    NA    NA
#> 16 16 2021-05-07   4     4     2    NA    NA
```

- pre: Before coffee
- post: After coffee

Post - Pre

```
(ecg_diff <- read_csv("../data/processed/ecg-diff.csv"))
#> # A tibble: 16 x 6
#>   id     date    water speed coffee diff
#>   <dbl> <date>   <dbl> <dbl>  <dbl> <dbl>
#> 1 1 2021-04-22     1     1     1     9
#> 2 2 2021-04-23     1     2     4     1
#> 3 3 2021-04-24     1     3     2     7
#> 4 4 2021-04-25     1     4     3     3
#> 5 5 2021-04-26     2     1     4     2
#> 6 6 2021-04-27     2     2     2     6
#> 7 7 2021-04-28     2     3     3     3
#> 8 8 2021-04-29     2     4     1     NA
#> 9 9 2021-04-30     3     1     2     NA
#> 10 10 2021-05-01    3     2     3     NA
#> 11 11 2021-05-02    3     3     1     NA
#> 12 12 2021-05-03    3     4     4     NA
#> 13 13 2021-05-04    4     1     3     NA
#> 14 14 2021-05-05    4     2     1     NA
#> 15 15 2021-05-06    4     3     4     NA
#> 16 16 2021-05-07    4     4     2     NA
```

- Our output becomes $\text{diff} = \text{post} - \text{pre}$

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References

Randomization Test

Section 4

Related Contents

Project Repo

My Github project for this experiment:

<https://github.com/ygeunkim/ecg-experiment>

himynnameisabcde (2020). r/nespresso - i received the caffeine content numbers for starbucks nespresso pods!

https://www.reddit.com/r/nespresso/comments/id31r5/i_recieved_the_caffeine_content_numbers_for/.

Lee, K. (2021). Design and analysis of experiments (sta5031).
<https://icampus.skku.edu>. Accessed: 2021-03-20.

한동하 (2018). [한동하 원장의 웰빙의 역설] 냉커피는 뜨거운 커피와 어떤 차이가 있을까?

<http://www.k-health.com/news/articleView.html?idxno=37375>.